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Does age modify the relationship between morbidity severity and physical health in English and Dutch family practice populations?

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Abstract
Purpose To investigate the co-inßuences of age and morbidity severity on physical health in adult family practice populations.
Methods Morbidity data in a 12-month period for 7,833 older English consulters aged 50 years and over and 6,846 Dutch consulters aged 18 years and over was linked to their physical health status obtained from cross-sectional health surveys. Individual patients were categorised using 78 consulting morbidities classiÞed by a chronicity measure (acute, acute-on-chronic and chronic) into an ordinal scale of morbidity severity ranging from single to multiple chronicity groups. Associations between morbidity severity, age and SF-12 Physical Component Summary (PCS) score were assessed using linear regression methods.
Results Increased age and higher morbidity severity were signiÞcantly associated with poorer physical health. Of the explained total variance in adjusted PCS scores, an estimated 43% was attributed to increasing age, 40% to morbidity severity and 17% to deprivation for English consulters; the Þgures were 21, 42 and 31%, respectively for Dutch consulters. The largest differences in PCS scores between severity categories were observed in the younger age groups.
Conclusions Morbidity severity and age mainly act separately in adversely inßuencing physical health. In ageing populations who will experience higher multimorbidity, this study underlines the importance that health care and public health will need to address morbidity severity and ageing as related but distinct issues.

Keywords Ageing · Comorbidity · Epidemiologic studies · Family practice · Quality of life

Introduction

Two of the strongest determinants of health deterioration are ageing and the illness process, as exempliÞed by the patientÕs experience of chronic disease [1, 2]. Much of current research has focussed on the pursuit of risk and modifying factors that affect the occurrence and progression of the single-disease process [3]. Yet, in the wider understanding of the contribution of illness and diseases to poorer health, it has been hypothesised that deterioration in health and the subsequent spiral of descent, as exempliÞed by the ÔfrailtyÕ concept, may not only be a part of the ageing process, but may be inßuenced by multiple morbidities that encompass the experience of ÔacuteÕ as well as ÔchronicÕ health states [4–6]. A key distinction to be made within this hypothesis is that an individual person may experience either a ÔsevereÕ but single morbidity type or that Ômorbidity severityÕ may encapsulate the experience of different types of morbidities or multiple morbidities that

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contribute to the overall health deficit. One approach to defining morbidity severity is the latter (type and multiple), since a majority of older people usually experience a range of morbidities. The experience of two or more morbidities over time in research terms has been defined as 'multimorbidity' [7]. Primary care studies of morbidity severity, as indicated by multimorbidity, have shown that it is negatively associated with overall health and is also associated with increased referrals and increased health care costs [8–10]. In ageing Western populations, the estimated numbers of older people with chronic diseases and the consequent multimorbidity will increase substantially. Therefore, this issue is set to become an increasingly important issue for public health and policy makers, as well as for clinicians and their patients.

It is well understood that changes in health are associated with the ageing process, which deteriorates from middle age to the poorest health reported by the oldest members of the general population [11, 12]. Current research shows that not only are individual chronic diseases associated with poor physical status [13], but that multiple chronic diseases are associated with ageing, deterioration in health and result in increased health care and related costs [14–16]. However, the precise course of health with transitions in ageing or with the occurrence of morbidity severity is unknown. A key issue, therefore, is raised: what is the relationship between (chronological) age and morbidity severity in relation to the outcome of poor health? Possible hypotheses include that: (i) the combined 'effects' of age and morbidity on physical health are specific and statistically distinct for different age groups, i.e. age is an effect modifier, (ii) the association between morbidity severity and poor health is partly explained by age (i.e. confounding), as age is linked to an increased likelihood of morbidity severity, (iii) age 'causes' higher morbidity severity (the latter becoming a mediating factor) that subsequently results in poorer health or (iv) age and morbidity independently influence poor health (Fig. 1).

Whilst the impact of individual chronic diseases is well understood, the role of other types of health events is less well understood and all of these terms suffer from a lack of standard definitions of the concepts. How do we define morbidity severity in the context of the population setting? The 'severity' concept could simply include few and specific chronic diseases or, in fact, could include many other types of illness and health states. Patients experience a range of morbidity over time, including symptoms, illnesses and specific 'chronic' diseases [17, 18], which, in the British setting, are routinely recorded by their General Practitioners (GPs) using computer-based systems. Over time, such records form an epidemiological record of the individual patient morbidity experience. To deal with the practical problem of defining the morbidity severity concept using terms such as 'acute' and 'chronic,' in the English setting, we have developed a new consultation-based severity measure of classifying morbidity according to chronicity through detailed consensus studies in England and validation studies in the Netherlands [19, 20]. By linking such consultation data with self-reported health data ascertained through population surveys, the

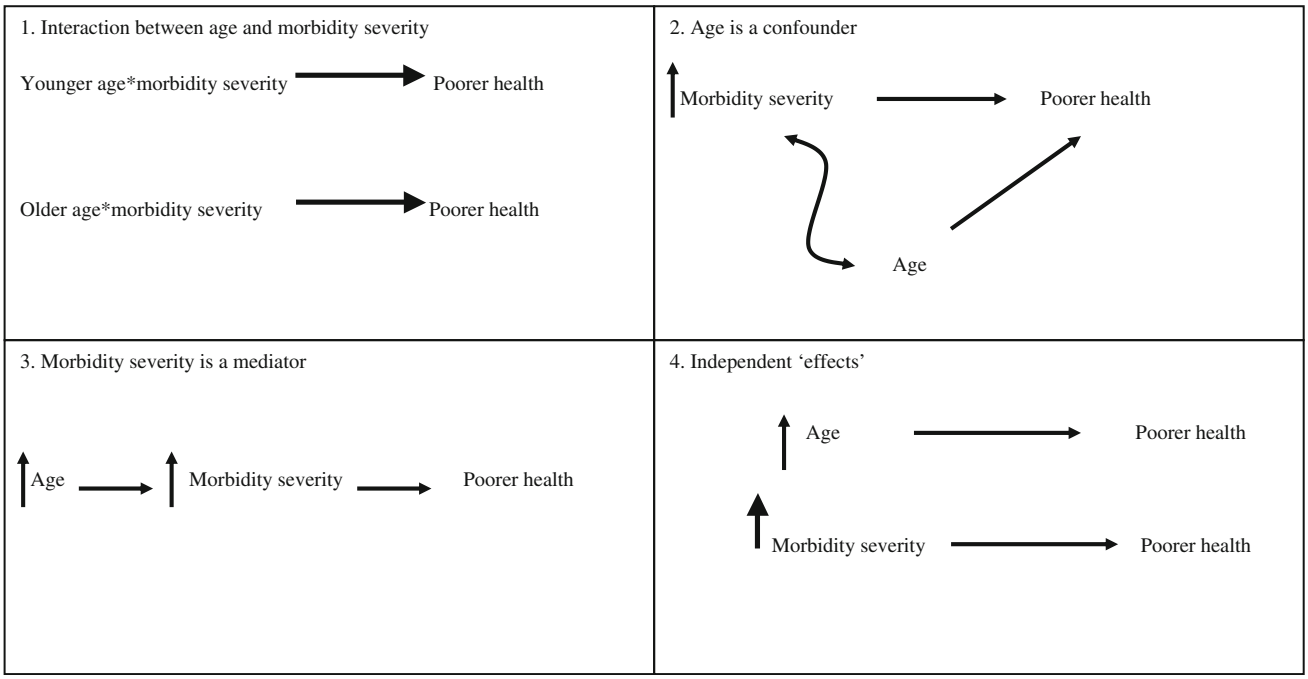

Fig. 1 Four hypotheses—relationship between age and morbidity severity in relation to physical health

investigation could be expanded to address the association between age, morbidity severity and physical health status in two separate consulting samples. The Dutch sample included the full adult range of 18 years and over, whereas the English sample was focussed on older adults aged 50 years and over, which meant that we could investigate the co-inßuences of age and morbidity severity on the overall physical health and its generalisability in cross-national populations.

Methods

Population and setting

In England, registered patients aged 50 years and over from six family practice populations had participated in a questionnaire survey, and this self-reported survey data was linked to their anonymised clinical data with consent for the 12 months before the survey (2001) [21, 22]. In the Netherlands, random adult samples aged 18 years and over from 104 family practices across the country had participated in interview surveys, and this data was linked to their concurrent clinical data for a 12-month period and which was also anonymised (Second Dutch National Survey, DNS2) [23]. Appropriate Research Ethics Committee approval was obtained for the English studies, but this was not a requirement for the DNS2 that related to the use of anonymised data.

The six study practices in England were part of the North Staffordshire General Practice Research Network (NSGPRN), which cover a wide range of socio-economic groups and includes over 70 GPs who had actively participated in the routine collection of clinical data using computer records. The DNS2 collected morbidity data from consultations recorded by 195 GPs in 104 family practices in the Netherlands for a 1-year period also in 2001.

In the English study, there were 8,791 surveyed patients with linked clinical data and who had at least one morbidity consultation in the 12-month period; non-consulters were excluded from this current study. In the DNS2, there were 7,753 patients identiÞed aged 18 years and over with linked clinical data and who had at least one morbidity consultation in the 12-month period. English GPs had used standard Read morbidity codes [24], whereas Dutch GPs had used the ICPC-1 (International ClassiÞcation for Primary Care) to code consulting morbidities [25].

Study measures

In the English postal and Dutch interview surveys, the validated Short-Form Medical Outcomes Study questionnaires had been used as a generic measure of health status [26, 27]. The outcome of interest in this study was physical health based on the Physical Component Summary (PCS) score of the SF-12, which ranges from 0 (poorest health) to 100 (best health) normalised to the US population. In England, residential postcodes for patients were used to determine deprivation status based on the Townsend score [28]. This score is based on 2001 national UK census data and uses data on housing quality, car ownership and the number of people in the household to produce a composite score of relative deprivation. The deprivation measure from DNS2 was based on individual monthly income data.

Morbidity severity deÞnition

The approach to deÞning morbidity severity was using an a priori ordinal scale of severity, as measured by chronicity, which was developed by GPs through detailed focus group and consensus methods and was validated [19, 20]. In the focus groups, GPs had explicitly deÞned morbidities as being either: (i) AcuteÑÔÔA condition whose onset and duration is short (lasting days), with only limited treatment required. The condition has a Þnishing pointÕÕ, (ii) Acute-on-ChronicÑÔÔA condition that is an exacerbation of a chronic illness with features of an acute illnessÕÕ or (iii) ChronicÑÔÔA condition that lasts a long time (months to years), which does not resolve and in which a risk of other health consequences persists. Treatment is often ongoing.ÕÕ In summary, 78 classiÞed morbidities common and speciÞc to both ICPC-1 and Read codes were categorised ordinally as acute (46 morbidities), acute-on-chronic (11) or chronic (21). We used the chronicity scale to classify individual consulters into ordered morbidity severity groups ranging from single to multiple combinations of chronicity categories (examples of the morbidities classiÞed with a 1-year period of prevalence for English and Dutch samples are given in Appendix 1). Cases were all patients who had consulted for at least one of the 78 classiÞed morbidities during the 12-month period under review. On the basis of the chronicity severity scale, individuals were categorised into Þve exclusive groups consulting for: (i) acute only, (ii) acute-on-chronic only, (iii) chronic only, (iv) multimorbid combinations of any two severity categories (i.e. acute and acute-on-chronic, acute and chronic, or acute-on-chronic and chronic) or (v) multimorbid combination of all three categories. ClassiÞcation by each chronicity category relates to at least one consultation in the study time period and does not include multiple consultations for the same severity category (for example, a person with the three chronic conditions of hypertension, osteoarthritis and diabetes would still appear in the chronic group only). The

reference group were patients who had consulted for all other morbidities not defined by the list of 78 morbidities in the chronicity classification. The reference groups for the English and Dutch samples were comparable to the registered but non-consulting group for the respective countries, and did not differ by mean age, social class status and mean PCS scores. In both populations, the consulting reference group were more likely to be females than males compared to the non-consulters (Appendix 2). Using this approach, for the final analysis, we had 7,833 consulters in the English sample and 6,846 in the Dutch sample.

Statistical analysis

Using the PCS score of the SF-12 questionnaire as the outcome measure, we first described mean scores with standard deviations for the Dutch and English consulters by age, gender, deprivation (Townsend data and Dutch income data were categorised into four ordinal groups ranging from 1 [deprived] to 4 [affluent]) and morbidity severity. We analysed each country data separately for our four hypotheses regarding the relationship between age and morbidity severity, using a combination of descriptive and multivariate modelling approaches and included gender and deprivation as alternative explanatory influences on physical health. First, to assess for interaction, unadjusted associations between age-stratified morbidity severity and PCS scores were estimated using linear regression modelling and a multivariate model was tested which included interaction terms for morbidity severity and either age, gender or deprivation categories. Unadjusted mean differences with 95% confidence intervals are presented relative to two reference groups: (i) within each age strata and (ii) overall in each sample. Second, to assess the confounding potential of age, we graphically present mean PCS scores with 95% confidence intervals stratified by age (18–34, 35–49 years (Dutch) and 10-year bands from 50 to 79 years and 80+ for both consulting populations) and multivariate analyses adjusting for study factors. These multivariate analyses are presented as variance in PCS scores explained by the study factors using unadjusted and adjusted estimates, and are expressed as a percentage of the total variance. Third, to assess whether morbidity severity is a mediator, it was assumed that any significant association between age (expressed as a continuous variable) and physical health would be abolished when adjusting for morbidity severity in the multivariable model. Finally, to assess whether age and morbidity severity were independent of each other, the estimated contribution to the variance in PCS scores for age and morbidity severity was calculated separately as a percentage of the adjusted total variance. All analyses were performed using SPSS version 15.0 for Windows.

Results

In comparison, Dutch consulters had higher PCS scores (indicating better physical health) than their English counterparts (Table 1). In both the English and Dutch samples, the mean PCS scores decreased with age. The average PCS score was higher for men compared to women, affluent compared to deprived, and was higher for those with lower severity compared to higher morbidity severity.

Interaction hypothesis

In Dutch consulters, within each of the age-stratified groups, there was a significant trend ($P < 0.001$) in the unadjusted associations between morbidity severity and low PCS score compared to their respective reference group (Table 2). However, the exception was the oldest age group of 80 years and older with a non-significant trend ($P < 0.08$). In English consulters, age-stratified morbidity severity showed similar unadjusted associations with low PCS scores. There was an increasing and significant trend within the age groups of 50–59, 60–69, 70–79 years ($P < 0.001$), as well as a less significant increasing trend in the oldest age of group 80 years and over ($P = 0.045$) for an association between morbidity severity and poor physical health. In the overall samples, there was an increasing and significant trend overall in poor health (lower PCS scores) with older age categories across parallel morbidity severity categories ($P < 0.001$) compared to their youngest age reference group (Table 2). Comparing models without and with interaction terms improved the total variance in the English sample from 16.2 to 16.9%, respectively, and in the Dutch sample from 14.2 to 14.5%, respectively. In the English sample, analyses showed that there was significant interaction between age and the three most severe morbidity categories: chronicity ($P = 0.002$), two multimorbid categories ($P = 0.003$) and all three-chronicity categories ($P = 0.001$). In the English sample (Table 2), within the youngest age group (50–59 years), the estimated mean difference in PCS score for the three most severe morbidity groups compared to the reference category was as follows: −5.8 for chronicity, −7.1 for two multimorbid categories and −12.8 for all three chronicity categories. In comparison, within the oldest age group of 80 years and over, the estimates were −1.4, −2.4 and −3.4, respectively. Whilst the Dutch analysis did not show significant interactions, similar patterns were observed, namely, that the mean differences in PCS scores for the most severe morbidity groups compared to the reference were largest within the youngest age group aged 18–34 years and smaller within the oldest age group of 80 years and over.

Table 1 Mean Physical Component Summary (PCS) scores (SF-12) for Dutch and English consulters by socio-demographic characteristics and morbidity severity

Variables	Categories	Dutch (n = 6,846)		English (n = 7,833)	
		Number	Mean PCS score (SD)	Number	Mean PCS score (SD)
Age (years)	18Ð34	1,447	50.4 (7.43)	Ð	Ð
	35Ð49	2,059	48.9 (8.40)	Ð	Ð
	50Ð59	1,250	47.0 (9.60)	2,355	43.4 (11.93)
	60Ð69	972	46.2 (9.84)	2,498	39.4 (12.16)
	70Ð79	798	43.9 (10.66)	2,129	36.5 (11.20)
	80+	320	39.6 (10.55)	851	32.5 (10.17)
Gender	Male	2,831	48.3 (8.88)	3,462	39.6 (12.08)
	Female	4,015	46.9 (9.75)	4,371	38.7 (12.19)
Social status[a]	Category 1 (deprived)	1,346	43.8 (10.65)	2,025	36.0 (11.66)
	Category 2	2,119	47.3 (9.54)	1,985	38.4 (11.99)
	Category 3	1,502	48.5 (8.59)	1,925	40.6 (12.01)
	Category 4 (afßuent)	1,534	49.8 (7.85)	1,876	41.6 (12.20)
Morbidity severity scale	Reference	2,205	50.1 (7.70)	1,428	43.2 (11.83)
	Acute	1,924	48.2 (8.88)	1,871	40.5 (12.12)
	Acute-on-chronic	509	47.1 (9.97)	499	40.6 (11.96)
	Chronic	850	45.7 (9.95)	1,986	37.6 (12.03)
	Any two categories	1,169	44.0 (10.32)	1,787	36.4 (11.63)
	All three categories	189	39.9 (11.23)	262	32.9 (10.00)

[a] The measure of deprivation in the Netherlands was based on income and in England, it was based on the Townsend score (enumeration ward), so the data was categorised into four groups to allow for comparison

Confounding hypothesis

The age-stratiÞed mean PCS scores by morbidity severity are given in Fig. 2. The scores decreased with increasing morbidity severity within each age-stratiÞed group and were lowest in the age group of 80 years and over. The graphical patterns were similar in both consulting populations. In both samples, multivariate analyses showed that the associations between morbidity severity and poor physical health were diminished after adjustment for age, gender and deprivation (Table 3). In the Dutch analyses, the mean difference in the PCS score comparing unadjusted vs. adjusted estimates for the most severe multimorbid severity groups was, respectively, as follows: any two chronicity categories Ð (−6.3 vs. −4.5) and all three categories Ð (−10.3 vs. −7.8). Similarly, in the older English analyses, the mean differences in PCS score for the most severe multimorbid severity groups were, respectively, as follows: any two chronicity categories Ð (−7.5 vs. −5.9) and all three categories Ð (−10.9 vs. −8.9).

Mediating hypothesis

In the Dutch sample aged 18 years and over, each increase in age of 1 year was associated with a decrease in the PCS score of −0.146, which remained signiÞcant after adjustment for morbidity severity, but which resulted in diminution of the estimate to −0.095 (Table 3). Similarly, in the English sample aged 50 years and over, each increase in age of 1 year was associated with a decrease in the PCS score of −0.392, which remained signiÞcant after adjustment for morbidity severity, but which resulted in diminution of the estimate to −0.327 (Table 3).

Independent ÔeffectsÕ hypothesis

The speciÞc study measures explained an estimated 14.2% of the variance in the Dutch physical health and 16.2% of the variance in the English physical health. In this adjusted model, age relatively explained an estimated 21% of the total variance in physical health in the adult Dutch sample aged 18 years and over, but 43% of the total variance in physical health in the older English sample (Table 3). After adjustment, the overall morbidity severity relatively explained an estimated 43% of the total variance in the Dutch physical health and 40% in the English physical health. Of the overall percentage variance in physical health related to morbidity severity, around an estimated 30% was attributable to the two most severe multimorbid groups in the Dutch analyses and the corresponding Þgure

Table 2 Age-stratified unadjusted estimates for the association between morbidity severity and poor physical function in the Dutch and English samples using simple regression

Age (years)	Morbidity severity	Dutch consulters			English consulters		
		No.	Mean difference[ab] (95% CI)	Mean difference[ac] (95% CI)	No.	Mean difference[ab] (95% CI)	Mean difference[ac] (95% CI)
18–34	Reference	680	Ref	Ref		N/A	
	Acute	490	−0.69 (−1.49 to 0.12)	−0.69 (−1.49 to 0.12)			
	Acute-on-chronic	119	−0.52 (−1.84 to 0.81)	−0.52 (−1.84 to 0.81)			
	Chronic	24	−2.64 (−5.38 to 0.10)	−2.64 (−5.38 to 0.10)			
	Any two categories	130	−4.55 (−5.91 to −3.18)	−4.55 (−5.91 to −3.18)			
	All three categories	4	−10.46 (−17.09 to −3.84)	−10.46 (−17.09 to −3.84)			
35–49	Reference	826	Ref	−0.82 (−1.55 to −0.10)			
	Acute	687	−1.50 (−2.31 to −0.70)	−2.33 (−3.13 to −1.52)			
	Acute-on-chronic	198	−2.62 (−3.84 to −1.39)	−3.44 (−4.60 to −2.28)			
	Chronic	117	−2.18 (−3.67 to −0.70)	−3.01 (−4.37 to −1.65)			
	Any two categories	208	−4.12 (−5.31 to −2.92)	−4.94 (−6.07 to −3.82)			
	All three categories	23	−8.58 (−11.78 to −5.37)	−9.40 (−12.27 to −6.53)			
50–59	Reference	343	Ref	−1.39 (−2.31 to −0.47)	589	Ref	Ref
	Acute	334	−1.91 (−3.20 to −0.63)	−3.30 (−4.29 to −2.31)	632	−2.08 (−3.31 to −0.85)	−2.08 (−3.31 to −0.85)
	Acute-on-chronic	100	−5.24 (−7.16 to −3.31)	−6.62 (−8.16 to −5.09)	208	−2.81 (−4.53 to −1.09)	−2.81 (−4.53 to −1.09)
	Chronic	196	−2.65 (−4.11 to −1.18)	−4.04 (−5.20 to −2.89)	421	−5.75 (−7.18 to −4.33)	−5.75 (−7.18 to −4.33)
	Any two categories	238	−6.14 (−7.62 to −4.65)	−7.52 (−8.67 to −6.37)	413	−7.06 (−8.50 to −5.62)	−7.06 (−8.50 to −5.62)
	All three categories	39	−10.08 (−12.81 to −7.36)	−11.47 (−13.71 to −9.23)	52	−12.83 (−15.87 to −9.79)	−12.83 (−15.87 to −9.79)
60–69	Reference	189	Ref	−1.69 (−2.82 to −0.56)	395	Ref	−3.68 (−5.10 to −2.27)
	Acute	216	−2.90 (−4.66 to −1.15)	−4.60 (−5.74 to −3.45)	560	−2.29 (−3.84 to −0.75)	−5.98 (−7.29 to −4.66)
	Acute-on-chronic	49	−3.43 (−6.21 to −0.64)	−5.12 (−7.15 to −3.08)	157	−4.11 (−6.33 to −1.89)	−7.79 (−9.73 to −5.85)
	Chronic	230	−3.48 (−5.26 to −1.71)	−5.17 (−6.31 to −4.04)	683	−4.58 (−6.08 to −3.08)	−8.27 (−9.54 to −7.00)
	Any two categories	239	−4.74 (−6.52 to −2.95)	−6.43 (−7.56 to −5.29)	575	−5.63 (−7.13 to −4.12)	−9.31 (−10.59 to −8.03)
	All three categories	49	−7.68 (−10.47 to −4.88)	−9.37 (−11.40 to −7.33)	75	−9.92 (−12.77 to −7.07)	−13.60 (−16.14 to −11.07)
70–79	Reference	122	Ref	−3.42 (−4.78 to −2.05)	309	Ref	−7.48 (−8.98 to −5.97)
	Acute	146	−3.77 (−6.11 to −1.44)	−7.19 (−8.51 to −5.87)	449	−2.30 (−3.95 to −0.64)	−9.77 (−11.12 to −8.43)
	Acute-on-chronic	31	−4.10 (−8.00 to −0.19)	−7.51 (−10.03 to −4.99)	79	−1.09 (−3.89 to 1.71)	−8.57 (−11.06 to −6.08)
	Chronic	203	−3.68 (−5.95 to −1.41)	−7.10 (−8.31 to −5.88)	611	−3.14 (−4.70 to −1.59)	−10.62 (−11.86 to −9.38)
	Any two categories	249	−4.89 (−7.14 to −2.64)	−8.30 (−9.50 to −7.14)	524	−4.40 (−5.96 to −2.83)	−11.88 (−13.14 to −10.61)
	All three categories	47	−8.14 (−11.44 to −4.84)	−11.55 (−13.63 to −9.47)	89	−6.25 (−8.88 to −3.62)	−13.73 (−16.07 to −11.39)

Table 2 continued

Age (years)	Morbidity severity	Dutch consulters			English consulters		
		No.	Mean difference[a,b] (95% CI)	Mean difference[a,c] (95% CI)	No.	Mean difference[a,b] (95% CI)	Mean difference[a,c] (95% CI)
80+	Reference	45	Ref	−9.81 (−11.90 to −7.72)	99	Ref	−13.08 (−15.35 to −10.81)
	Acute	51	−0.60 (−4.91 to 3.71)	−10.41 (−12.41 to −8.40)	180	−0.18 (−2.88 to 2.51)	−13.26 (−15.05 to −11.48)
	Acute-on-chronic	12	−2.11 (−9.22 to 5.00)	−11.92 (−15.81 to −8.02)	41	0.05 (−3.93 to 4.03)	−13.03 (−16.39 to −9.66)
	Chronic	80	−0.43 (−4.29 to 3.43)	−10.24 (−11.90 to −8.58)	226	−1.39 (−3.87 to 1.10)	−14.47 (−16.08 to −12.85)
	Any two categories	105	−3.14 (−6.68 to 0.40)	−12.95 (−14.43 to −11.47)	241	−2.37 (−1.66 to −0.07)	−15.45 (−16.98 to −13.91)
	All three categories	27	−5.31 (−10.26 to −0.37)	−15.12 (−17.75 to −12.50)	35	−3.37 (−7.40 to 0.65)	−16.45 (−20.04 to −12.87)

[a] Unadjusted

[b] Reference group is within each age group respectively

[c] Youngest age group reference group is the comparator for the whole stratiÞed sample

for the English sample was around 25%. Of the remainder, deprivation but not gender also explained the larger part of the variance in physical health in both samples.

Discussion

Our study Þndings are drawn from two international study samples and showed three speciÞc Þndings. First, the associations between morbidity severity and physical health, and age and physical health are largely independent of each other, even allowing for a smaller role of confounding by age. Second, there was some evidence for an interaction between age and morbidity severity: it seems likely that the combined effects of increased morbidity severity and age are less in their adverse inßuence on physical health than the addition of each individual Ôeffects.Õ Third, the validity of the conclusions are supported by the consistency in patterns of association between morbidity severity, age and poor physical health within age strata across consulting populations drawn from two different countries.

Previous studies have shown that age and higher morbidity severity are associated with poor physical health [1, 15], but our study shows that the inßuence of morbidity severity, particularly as measured by multimorbidity, in adult and older populations is separate to the inßuence of age. One implication for clinical practice is that the emphasis on older age as a target group for care should, perhaps, be revised to give more priority to tackling morbidity severity as a basis for health care interventions, regardless of a personÕs age. Whilst clinicians often operate in addressing health needs irrespective of age, debate on future priorities for health care and public health policy are currently Þxed in the context of ageing populations who will experience higher multimorbidity, but our study suggests that distinctive approaches may be preferential. There is also much current interest in the transition between disability and in the concept of ÔfrailtyÕ as relating to the accumulation of health deÞcit, especially in relation to ageing [11, 29]. However, the population transitions of health in differing ages are not fully known. Verbrugge and Jette [4] and Fried et al. [5] have suggested that there may be links between age and morbidity in the ÔÔspiral of descent and health deteriorationÕÕ that may occur in the ageing process, and which is associated with events such as the experience of inter-current acute and multiple morbidities. Our study, through the use of a simple tool based on the severity of morbidity as measured by chronicity and as applied in family practice populations, provides empirical evidence for such a possibility.

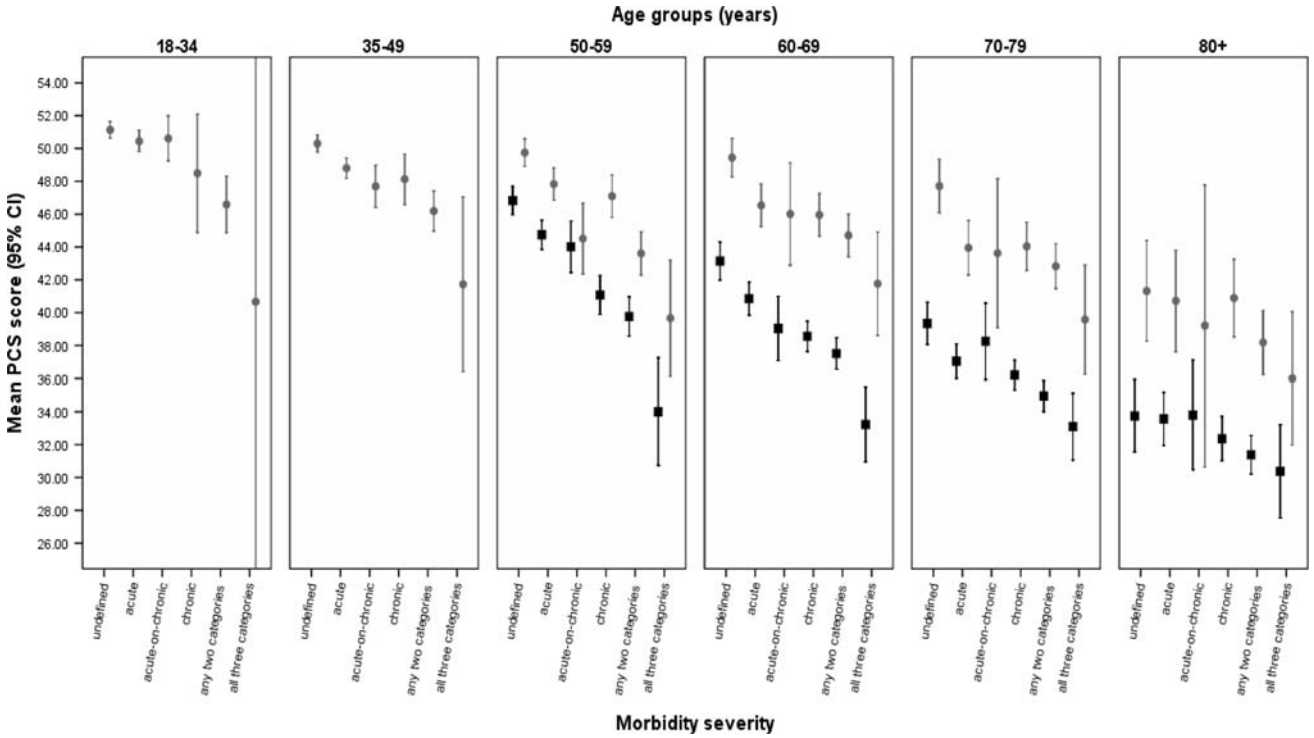

Fig. 2 Age-stratified mean PCS scores (95% CI) for Dutch and English populations by morbidity severity. Square error bars English sample and round error bars Dutch sample

In terms of assessing the potential of combined (interaction) influences of morbidity severity and age on physical health, significant results were found for the English consulters, but not the Dutch consulting population. Possible explanations for such differences include the role of chance, the smaller numbers for the Dutch sample who also had relatively better physical health compared to their English counterparts and whether morbidity severity patterns differ with the type of family practices. Descriptive analysis did, however, show that, in fact, it was the younger age groups compared to the older groups that had the largest differences in physical health for the highest morbidity severity relative to lower severity in both populations, and this related specifically to the group defined as the most (multimorbid) severe group. This finding is arguably counterintuitive to the observation that, overall, older populations have worse physical health than younger populations, as also found in our study. Higher baseline risks in the older age groups may be a possible explanation, but this affects relative risks more than differences in risks. The use of a generic instrument to measure physical health with its attendant limitations could possibly influence our interpretation (e.g. ceiling effects for older age groups), but the same trends for two different populations does seem to provide empirical evidence for this finding. Within-age group analyses also showed that the differences in physical health were not as significant between single categories of acute, acute-on-chronic and chronic categories. Current health care systems focus on the management of chronic diseases, and this finding suggests that other types of non-chronic morbidity may need to be considered as equal indicators of health need. An additional interpretation is that ÔconsultationÕ in itself, irrespective of morbidity severity, is a marker of poor health status. Further prospective studies may further disentangle these findings.

Our study used a specific classification to define morbidity severity based on the chronicity classification, and different definitions of severity may provide alternative interpretations. The specific strength of the classification was that it has undergone measures of validation and testing. One caveat to the approach is that it relates to the defining of morbidity severity based on consultations, whereas individual patients may actually suffer from different severities of the same morbidity. The advantage of our approach is that morbidity severity can be applied to population-level studies of epidemiology, and such concepts are readily accepted [30], but alternative studies of ÔseverityÕ may relate to the actual experience of the morbidity by the patient. The other key issue, which was specific to the study, was that morbidity severity was defined on the basis of a 12-month time period of

Table 3 Estimated percentage variance attributable to the explanatory factors for the Dutch and English consulters using linear regression

Country	Explanatory factor	Unadjusted		Adjusted				
		B	Single factor variance (R^2)	B	95% CI	Variance (R^2)	% of total R^2	% of total R^2
Dutch consulters 18 years+	Age 18+[a]	−0.146	0.075	−0.095	−0.107 to −0.084	0.030	21.1	21.1
	Acute	−2.023	0.007	−1.788	−2.244 to −1.333	0.007	4.9	42.2
	Acute-on-chronic	−3.098	0.005	−3.048	−3.838 to −2.258	0.006	4.2	
	Chronic	−4.585	0.019	−2.388	−3.046 to −1.730	0.006	4.2	
	Any two categories	−6.269	0.047	−4.459	−5.028 to −3.891	0.026	18.3	
	All three categories	−10.300	0.024	−7.828	−9.114 to −6.542	0.015	10.6	
	Female	−2.033	0.012	−1.479	−1.829 to −1.130	0.008	5.6	5.6
	Soc. status categ. 2	3.341	0.016	2.343	1.842 to 2.843	0.009	6.3	31.0
	Soc. status categ. 3	4.689	0.028	2.944	2.402 to 3.486	0.013	9.2	
	Soc. status categ. 4	5.847	0.045	3.832	3.291 to 4.372	0.022	15.5	
	Total	Ð	Ð	Ð	Ð	0.142	100	100
English consulters 50 years+	Age 50+[a]	−0.392	0.104	−0.327	−0.348 to −0.305	0.069	42.6	42.6
	Acute	−3.388	0.009	−2.751	−3.358 to −2.144	0.006	3.8	40.1
	Acute-on-chronic	−3.332	0.003	−3.291	−4.339 to −2.244	0.003	1.8	
	Chronic	−6.292	0.033	−4.606	−5.206 to −4.007	0.017	10.8	
	Any two categories	−7.500	0.043	−5.899	−6.521 to −5.276	0.027	16.6	
	All three categories	−10.993	0.017	−8.892	−10.322 to −7.462	0.011	7.1	
	Female	−1.134	0.002	−0.379	−0.802 to 0.043	0.000	0.1	0.1
	Soc. status categ. 2	2.663	0.006	2.120	1.525 to 2.716	0.004	2.3	17.1
	Soc. status categ. 3	4.767	0.019	3.416	2.822 to 4.010	0.010	6.1	
	Soc. status categ. 4	5.648	0.027	4.135	3.535 to 4.735	0.014	8.7	
	Total	Ð	Ð	Ð	Ð	0.162	100	100

[a] Age is a continuous variable; Soc. status categ. is the social status category, where category 4 is the most affluent

consultations. This time period provided a snapshot of the morbidity encounters and it is likely that chronic diseases, especially those that are a part of monitoring systems, will be recorded annually. However, different time frames (either shorter or longer) or settings may provide changing and different patterns of morbidity severity, for example, self-limiting morbidity, even within the same individual [31].

Using an all-age adult population from the Netherlands and an older population aged 50 years and over from England, our study results showed similar patterns between morbidity severity, age and poor physical health, providing one perspective on the transitions of health with age and a basis for the generalisability of our findings. In conclusion, our study suggests that the association of morbidity severity as defined by chronicity with poor physical health may be separate to the influence of age. Overall, morbidity severity plays an equally important role as a determinant of health status and health care policy will need to incorporate this finding. In ageing populations, the importance of acknowledging the role of multimorbid severity in contrast to single-disease approaches will need to be recognised and prioritised in public health policies. Further work is underway to determine how morbidity severity can be incorporated into actual consultations to aid the clinical decision-making process and for the assessment of suitable interventions in the clinical populations.

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Appendix 1

Examples of the morbidities classified with a 1-year period of prevalence for English and Dutch samples (Table 4).

Table 4 Twelve-month period of prevalence (percentage Þgures) for the Þve most prevalent morbidities classiÞed by chronicity

		Acute	Acute-on-chronic	Chronic
English consulters aged 50 years and over	1	Bronchitis (9.0)	Asthma (4.7)	High blood pressure (20.0)
	2	Upper respiratory infection (7.4)	Anxiety states (4.4)	Generalised osteoarthritis (8.7)
	3	Wax in ear (7.2)	Oesophagitis (1.8)	Diabetes mellitus (6.5)
	4	Urinary tract infection (5.1)	Allergic rhinitis (1.3)	Hypercholesterolaemia (6.1)
	5	Conjunctivitis (2.9)	Gouty arthropathy (1.0)	Hypothyroidism (1.5)
Dutch consulters aged 50 years and over	1	Urinary tract infection (7.5)	Lumbosacral root lesions (3.8)	High blood pressure (21.1)
	2	Dermatophytosis of foot (6.6)	Asthma (2.7)	Diabetes mellitus (8.6)
	3	Wax in ear (6.5)	Oesophagitis (2.1)	Hypercholesterolaemia (6.1)
	4	Bronchitis (5.4)	Allergic rhinitis (2.0)	Emphysema (3.8)
	5	Sinusitis (3.1)	Gouty arthropathy (1.8)	Hypertensive heart disease (3.1)
Dutch consulters aged 18Ð49 years	1	Dermatophytosis of foot (7.4)	Allergic rhinitis (5.3)	High blood pressure (2.7)
	2	Sinusitis (6.4)	Asthma (3.0)	Hypercholesterolaemia (1.0)
	3	Urinary tract infection (4.7)	Lumbosacral root lesions (2.3)	Diabetes mellitus (0.9)
	4	Wax in ear (3.7)	Anxiety states (1.6)	Rheumatoid arthritis (0.6)
	5	Bronchitis (2.7)	Haemorrhoids (1.6)	Obesity (0.6)

Appendix 2

Comparison of sub-groups of the study to the overall groups (Table 5)

Table 5 Comparison of selected study sub-groups to the overall samples by explanatory factors in the two countries

	Explanatory factor	Non-consulters	Reference group	ClassiÞed group[a]	Overall study sample	Overall surveyed sample
English sample (50+ years)	Number	2,229	1,428	6,405	7,833	11,232
	Age in years (SD)	63.4 (9.76)	63.7 (9.78)	66.8 (9.98)	66.3 (10.0)	65.3 (10.1)
	Male (%)	52.3	48.1	43.3	44.2	46
	Female (%)	47.7	51.9	56.7	55.8	54
	Social status category 1 (%)	22.2	21.3	26.9	25.9	25.1
	Social status category 2 (%)	23	23.0	25.9	25.3	24.8
	Social status category 3 (%)	28.2	26.4	24.2	24.6	25.3
	Social status category 4 (afßuent) (%)	26.6	29.3	22.8	23.9	24.4
	Mean PCS score (SD)	46.6 (10.7)	43.2 (11.8)	38.2 (12.0)	39.1 (12.1)	40.7 (12.2)
Dutch sample (18+ years)	Number	1,911	2,205	4,641	6,846	9,664
	Age in years (SD)	45.2 (15.7)	43.5 (15.5)	53.0 (17.3)	49.9 (17.4)	48.9 (17.0)
	Male (%)	59.4	41.3	41.4	41.4	44.7
	Female (%)	40.6	58.7	58.6	58.6	55.3
	Social status category 1 (%)	15.8	15.4	22.1	19.7	25.1
	Social status category 2 (%)	30.1	30.7	31.9	31.0	24.8
	Social status category 3 (%)	25.5	25.7	20.8	21.9	25.3
	Social status category 4 (afßuent) (%)	28.7	28.2	20.4	22.4	24.4
	Mean PCS score (SD)	51.4 (7.2)	50.1 (7.7)	46.2 (9.9)	47.5 (9.4)	48.3 (9.1)

[a] ClassiÞed by the chronicity severity classiÞcation

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